Appendix A Vendor Claims

(Note: All information in this appendix was provided by the vendor, Rocky Mountain Remediation Services (RMRS). Inclusion of any information is at the discretion of RMRS, and does not necessarily constitute U.S. Environmental Protection Agency concurrence or endorsement.)

A1. Introduction

In the past five years, Rocky Mountain Remediation Services, L.L.C. (RMRS) has developed and field deployed an innovative, easy to use process for immobilizing heavy metals in soils and soil-like waste. This process uses a non-hazardous chemical binder called Envirobond™ that chemically binds metal contaminants, preventing leaching under the most stringent conditions. RMRS has successfully deployed the technology at locations throughout the United States. Envirobond™ can be adapted in a variety of ways at mining sites, soil washing projects, sediment removal sites, and others to produce a treated product that meets criteria for on-site containment, storage, or off-site disposal. The technology can be adapted for a variety of waste streams and soil conditions, and binds many types of heavy metals at high levels of contamination, including arsenic, barium, chromium, lead, silver, cadmium, selenium, and zinc below the Resource Conservation and Recovery Act (RCRA) treatment standards. Laboratory data indicate that the binder is also effective in treating radionuclides such as uranium, thorium, radium, and strontium.

When desired, the Envirobond™ process can be taken a step further to produce a solidified monolith, called Envirobrics™. Envirobric™ has also been developed and tested for chemical and physical stability, including laboratory, pilot and full scale testing. It resists water, and has passed a 24-hour immersion test. The Envirobric™ process uses off-the-shelf, high throughput equipment, and is therefore highly cost-effective. It also reduces the bulking factor and volume of the final waste form to 30%-40%, which makes it easier to handle and dispose of. This very simple process does not create secondary waste streams, nor does it require the addition of heat. Thus, the capital equipment cost is low and there are no special environmental or safety issues associated with the process.

A2. The Envirobond™ Process

Rocky Mountain Remediation Service's patent pending Envirobond™ metals treatment process employs a combination of proprietary phosphate materials. The formulation and application may vary somewhat depending on the concentration and species of metals to be stabilized. The phosphate compounds provide electrons at the oxygen sites that form a covalent bond with the heavy metals. The metal is incorporated into the phosphate structure which has the ability to immobilize the metal and is not affected by changes in pH. Chemically, the Envirobond™ phosphates form P-O-P chains that have very little steric hindrance to internal rotation. The internal rotation of the phosphate chains allows metals to react with the negatively charged oxygen to form spiral and coiled P-O-P chains that create complex, stable metallic bonds. The result is the formation of metallic phosphates that possess stronger, longer-lasting bonds than the metal-carbonate bonds found in natural apatite stabilization compounds.

A3. Effectiveness of Envirobond™

In a treatability study conducted last year, mill tailings with high levels of arsenic, cadmium, chromium, and selenium were successfully treated (see Figure 1). In this study the waste was treated for cadmium, chromium, and selenium. Arsenic was also present at elevated levels. However, the TCLP level before treatment was not of concern, and as a result, the Envirobond™ formulation was not directed at arsenic. The results for these samples are well below the TCLP RCRA standard for all metals, and also meet the Universal Treatment Standard for all but chromium, which is 0.1 ppm above the UTS. Laboratory testing has shown that Envirobond™ is effective for other RCRA metals, extremely high levels of lead and other metals of concern such as beryllium, mercury, nickel, and zinc (see Figure 2).

A4. Cost Analysis

The cost of using Envirobond™ is significantly reduced when compared to traditional cement-based technologies. Envirobond™ can be applied using methods that range from simple agricultural type mixing (i.e., land farming) to traditional pug mill mixing. Because it can be applied in a wet or dry form, it can be adapted to many situations to reduce the cost of equipment and handling.

Treatment on-site is often very cost-effective because it avoids transportation and disposal costs. If the material can be used for fill, avoiding the cost of purchasing clean fill creates even more savings. The major disadvantage to on-site disposal is that the use of traditional cement, lime, or other similar additives will add large amounts of material to the waste, and some of these treatments are not effective enough to allow for on-site burial. Some metals such as cadmium, selenium, or zinc cannot be treated without adding large volumes of additives. With cement or

lime, the heavy metals may not leach out, but they are still available to future environmental upsets because they are not permanently bound to the chemical additives. For these reasons, regulators are not willing to allow wastes to be disposed of on site, and, in many cases, have insisted that the waste be excavated and removed. With the superior results of Envirobond™, regulators will often reconsider this position.

Costs are significantly reduced when compared to cementation or excavation and hauling. With cementation, the additional bulking of the waste can easily add a 100% volume increase. The cost of materials handling and mixing is also higher. With excavation and hauling, there are additional transportation and disposal costs, and the excavated material may need to be replaced with clean fill. Figure 3 shows the savings that may result when Envirobond™ is used in place of cement-based technology. The cost per ton is greatly affected by the type of waste and by the total number of tons. Generally the cost to use Envirobond™ is $5 to $30 per ton less than cement-based products.

Figure 1. Mill Tailing Treatability Data (in ppm)

Parameter	TCLP Before Treatment	Envirobond Treated Result #1	Envirobond Treated Result #2	Envirobond Treated Result #3	Envirobond Treated Result #4	Envirobond Treated Result #5	Average of 5 Results on Original Sample	RCRA Treatment Standard	UTS Treatment Standard	Total Metals	
										Arsenic	1920
Arsenic	0.5	N/A	0.27	0.55	0.27	1.0	0.5	5	5	Barium	190
										Cadmium	27
Cadmium	0.18	0.11	0.002	<0.1	0.21	0.002	0.08	1	0.11	Chromium	570
										Lead	880
Chromium	13	0.42	0.92	.57	0.73	0.85	0.7	5	0.6	Mercury	<0.1
										Selenium	200
Selenium	1.95	0.69	0.75	1.4	0.9	0.76	0.9	5.7	5.7	Silver	<10

N/A = Not Available

Figure 2. Laboratory Results for RCRA Metals & Others

RCRA Metals	As	Ba	Cd	Lead	Nickel	Zinc	Beryllium
Total Prior to Treatment (ppm)	500	1180	27	40800	500	500	>5000
TCLP Extract Analysis (ppm)							
Sample	4.7	1.1	<0.002	<0.05	9	3	0.093
Sample	4.3	0.7	1.6	0.3	7.8	2.6	0.066
Sample		3.1	<0.002	0.12	4	1.1	
TCLP LDR Standard	5	100	1	5	N/A	N/A	N/A
Univerisal Treatment Standard	5	21	0.11	0.75	11	4.3	1.22
N/A = Not Available							

Figure 3. Application Methods and Pricing		
Method	Typical Envirobond Project	Traditional Cement and Silicates
Ex situ Mixing	$10-$30/ton	$30-$50/ton
In situ Landfarming	$5-25/ton	$20-$40/ton